THE FLANNER

Free
Expansion
Safety

ATER TUBE BOILERS

THE TOLEDO-FLANNER
BOILER COMPANY
TOLEDO, OHIO, U. S. A.

The Flanner Free Expansion Safety Water Tube Boiler

of the

BOX HEADER TYPE

so designed as to overcome the rigid construction, successfully solving the question of expansion and contraction, also noted for its Free and Rapid Circulation

JOS. F. GROSSWILLER, *Pres.*
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Built and Installed by

The Toledo-Flanner Boiler Company ∴ *Toledo, Ohio, U. S. A.*

The Flanner Free Expansion Safety Water Tube Boiler

That the Water Tube was a more recent invention than the Fire Tube Boiler is a mistaken idea. At the time Watt was experimenting with the steam engine in1766, James Blakey conceived the idea of furnishing the power by means of several tubes in a furnace, alternately inclined at opposite angles, connected at their contiguous ends by smaller pipes, which did not prove to be a success.

It was left to an American inventor to build a Water Tube Boiler that could be used successfully. James Rumsey may be truly classed as the originator of the Water Tube Boiler. His patent came out in England in 1788, since which time patents have been issued by the hundreds, some good, some poor.

It would take pages were we to undertake to give the reader all the different ideas of how a Water Tube Boiler should be made. Your time is too valuable to consider the failures. The successes are few and are narrowed down to two types — the Horizontal and Vertical. Both of these types are in successful operation all over the world, wherever steam power is used.

The Horizontal is, by far, the most popular type in use. There are a large number of varieties, which cover over 90 per cent. of all the Water Tube Boilers in use in the world today.

The boiler which we are representing to you in this Catalog is of the Horizontal type, the principle of which has been in general practical use for many years. The experienced engineer will recognize at once the improvements we have made over the older styles. The question of expansion and contraction have been overcome.

Trouble and grief have been constantly with the engineer in trying to keep in operation your old boiler of the Box Header type. The inventor has not been inclined to help him out of his trouble by correcting the defects of his boiler, for several reasons:

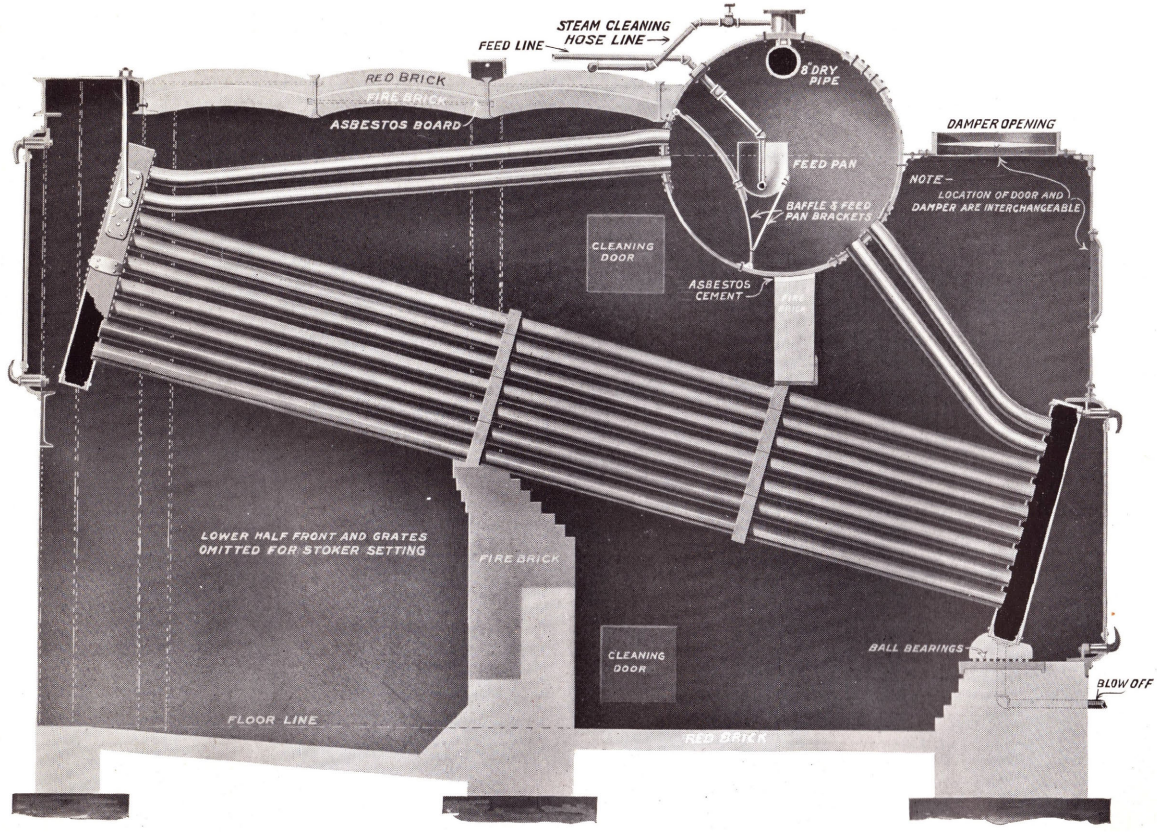
FIRST—He did not want to admit his boiler was defective.

SECOND—He might be infringing on other patents.

THIRD—It would cost too much to change his design. Cheapness of construction at the cost of maintenance has been the fault which has been left to the salesman to overcome.

In our long experience, we have made a thorough study of design, construction and the operation of boilers, which enables us to profit, not only by our own experience, but by the experience of others, which has enabled us to produce a **Boiler** superior to any in its class. Our design is such that we have absolutely taken care of one of the most destructive agencies, namely, unequal expansion and contraction, and is therefore productive not only of safety and long life to the boiler, but reduces the cost of maintenance to a minimum. The practical man will fully appreciate what this means. The design which we are offering will also show a very rapid circulation, which is an important factor in increasing the efficiency. We have ample liberating area, nearly 50 per cent. more than any boiler of the horizontal drum type. Our large steam drum gives us plenty of water capacity. Also plenty of steam space. **No foaming in this Boiler. Less than 1% moisture in the steam guaranteed.**

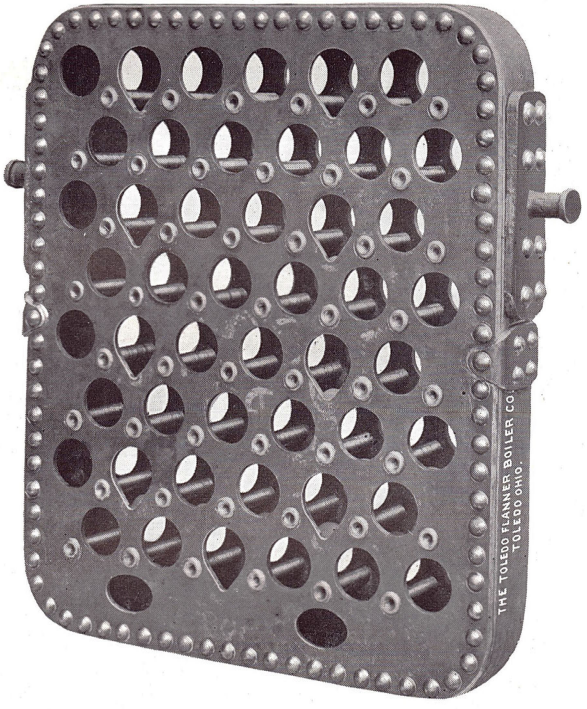
The Toledo-Flanner Boiler Co., *Toledo, Ohio, U. S. A.*


STEAM CLEANING HOSE LINE
FEED LINE
8" DRY PIPE
RED BRICK
FIRE BRICK
ASBESTOS BOARD
DAMPER OPENING
FEED PAN
NOTE – LOCATION OF DOOR AND DAMPER ARE INTERCHANGEABLE
BAFFLE & FEED PAN BRACKETS
CLEANING DOOR
ASBESTOS CEMENT
FIRE BRICK
LOWER HALF FRONT AND GRATES OMITTED FOR STOKER SETTING
FIRE BRICK
CLEANING DOOR
BALL BEARINGS
BLOW OFF
FLOOR LINE
RED BRICK

The picture on opposite page will call your attention to some of the details of the **Flanner Free Expansion Safety Water Tube Boiler.** Write to us about it. We know if you are in the market for a boiler you cannot help but be interested in this boiler. You will readily see we have solved the question of expansion and contraction. Note the radius of the top tubes to take care of the drum expansion, also the ball bearings enabling the boiler to go and come free from the brick work. Also note that we have nearly 50 per cent. more liberating area than any other type of boiler. Having two rows of 4-inch delivery tubes entering the steam drum, also the same number of circulation tubes. Write us and we will be pleased to answer you explaining why this boiler is the best of its class. For **economy, durability and quality of steam, it has no peer.**

THE FLANNER FREE EXPANSION SAFETY WATER TUBE BOILER
BUILT BY
THE TOLEDO FLANNER BOILER CO.
TOLEDO, OHIO
LOWER HALF FRONT AND GRATES
OMITTED FOR STOKER SETTING

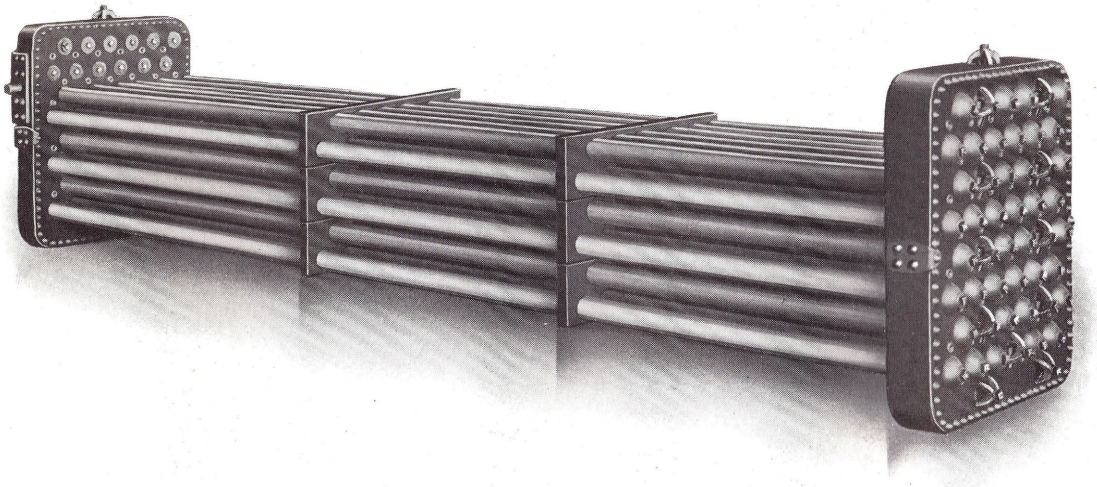
This picture shows the front frame of the **Flanner Free Expansion Safety Water Tube Boiler,** which, you will note, is made of heavy structural iron, so constructed as to stand a strain five times that which is required of it. You will also note the head swinging in the frame entirely free from contact with wall or frame which enables it to take care of all expansion and contraction.



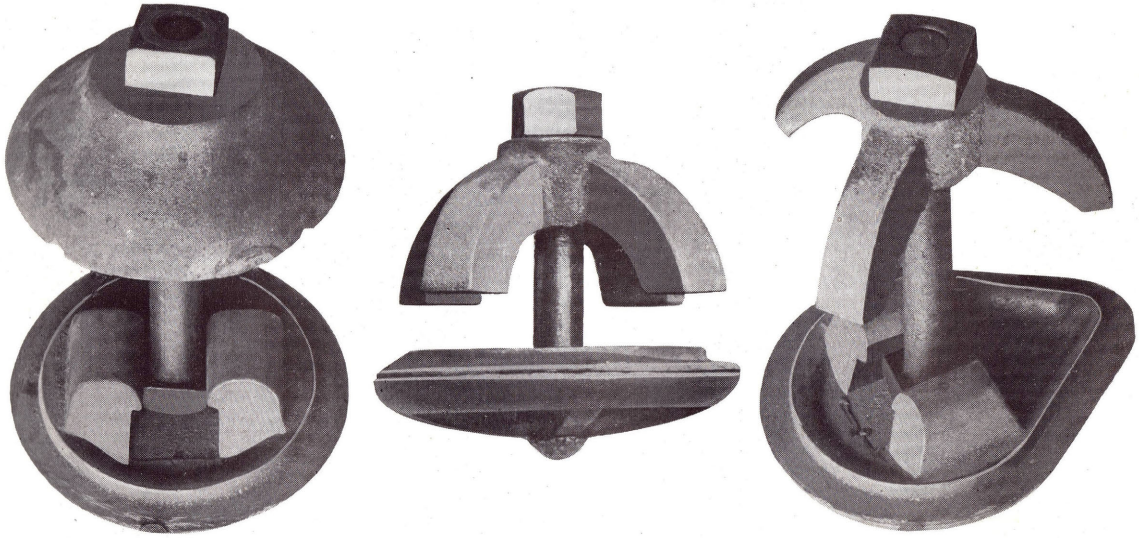
Stay Bolt.

This picture shows the detailed construction of our Box Header. The arms on the side of the head are for connecting the suspension rods from the heavy channel beam frames to the head. The staybolts are 1⅜-inch of the best staybolt iron obtainable.

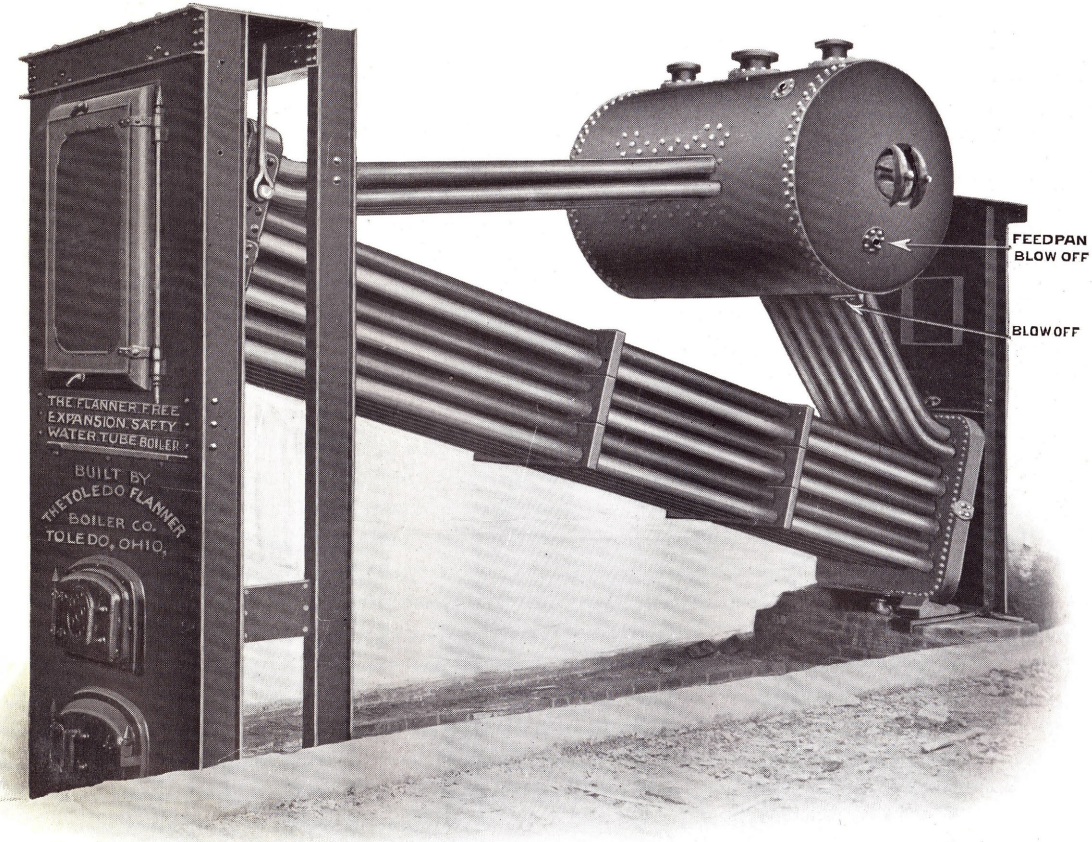
All staybolt iron is tested cold as shown in small picture above. This will assure you of the quality of material selected to go into our boilers.



This picture shows headers and tubes set up and rolled with caps in place ready for testing. The two top rows are for the circulation tubes. Any number of horsepower of the **Flanner Free Expansion Safety Water Tube Boiler** can be built up in this way.

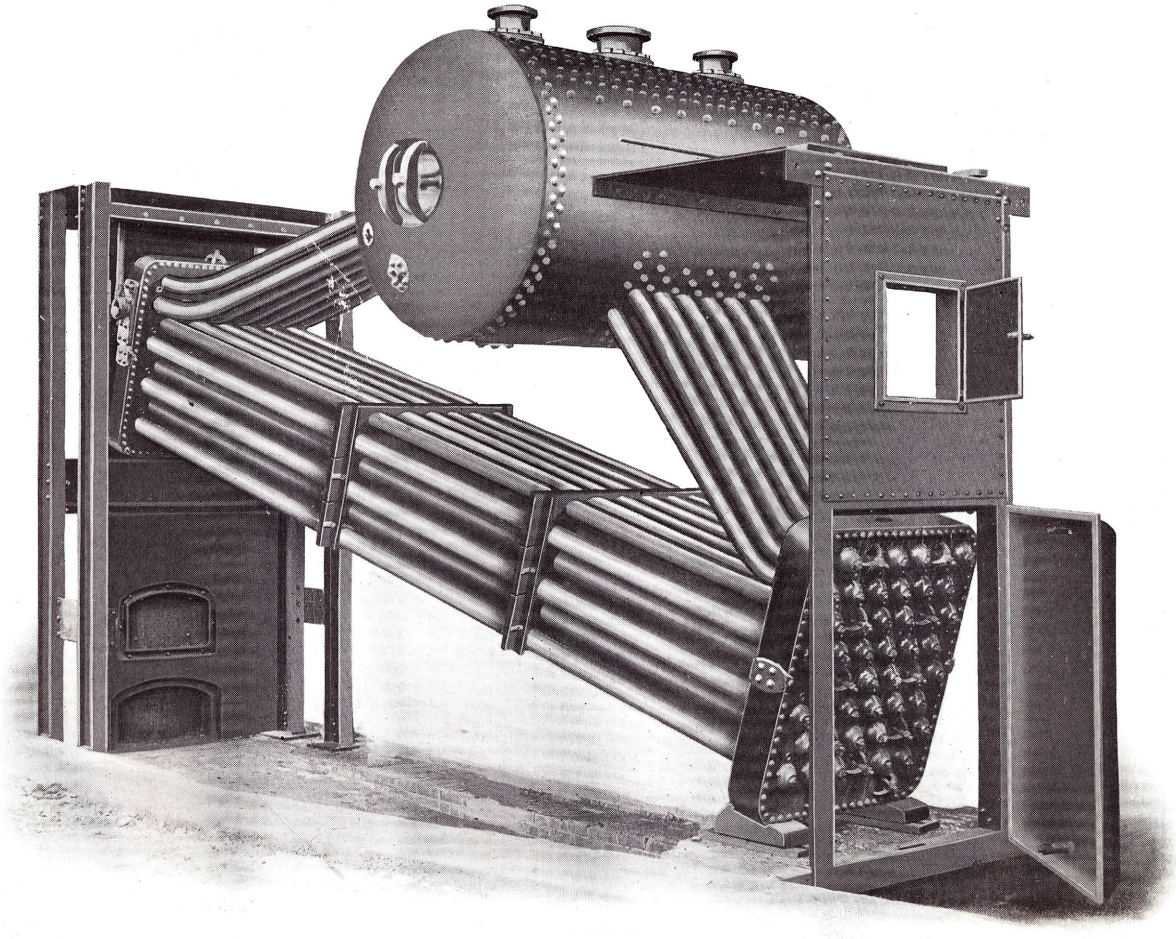


All caps as shown in illustration above are of inside pattern; no pressure parts held in place by bolts and nuts.

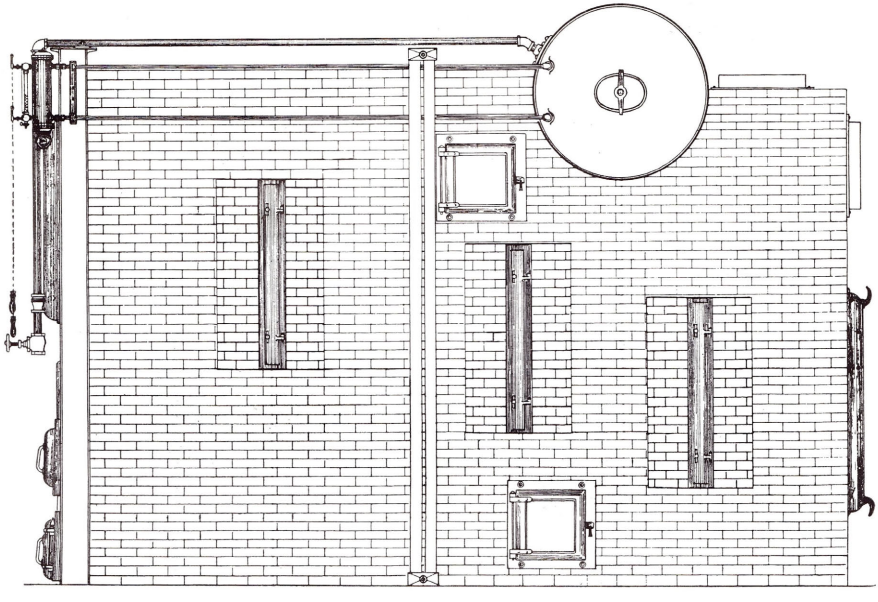


This picture shows side and front elevation of **Flanner Free Expansion Safety Water Tube Boiler** ready for testing. All boilers are tested to a pressure of 250 pounds with either hot or cold water, before brick work is started. We call your attention to the blow-off in the Feed Water Pan and also in the Steam Drum, which enables you to clean the boiler entirely from the outside.

We call your attention to the curve in the circulating and delivery tubes—made especially to take care of the expansion and contraction.

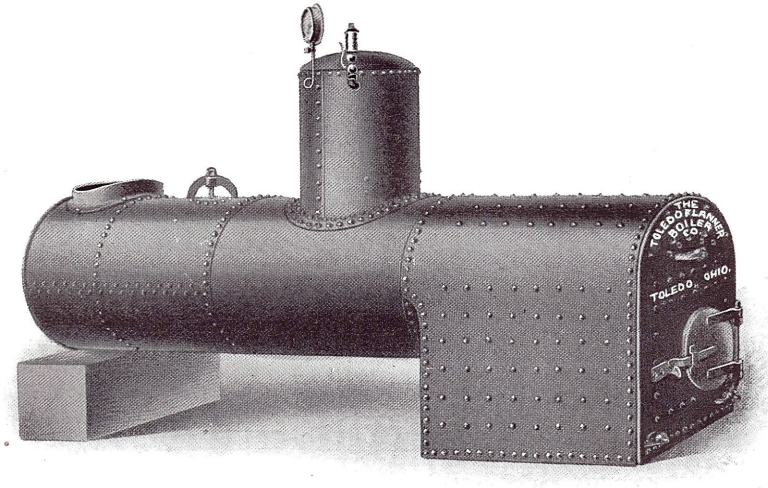


This picture shows side and rear elevation of a Flanner Free Expansion Safety Water Tube Boiler erected ready for testing. We especially call your attention to the baffle walls—how they are locked in place by flame bars. These walls are solid and will not break while inserting or removing a tube. So far as we know the **Flanner Water Tube Boiler** is the only boiler built, where the tubes can be inserted or removed without disturbing the baffle. You will note the rear frame is constructed with doors closing up the rear end of boiler—other designs are left open.



ELEVATION OF SIDE WALL.

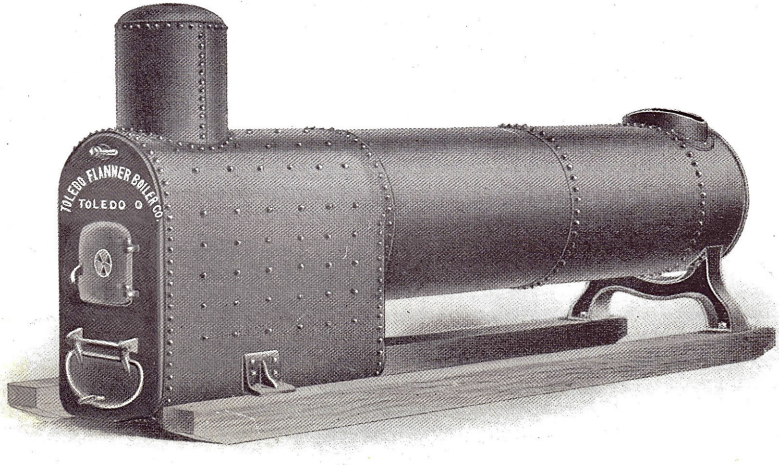
The Flanner Free Expansion Safety Water Tube Boiler, Box Head Type, erected complete and ready for steam.



Fire Box Boiler No. 8.

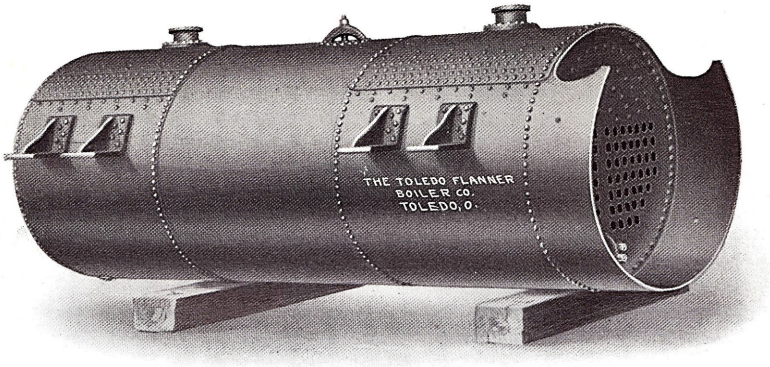
We build all styles of this kind of boiler. Do not fail to get our prices.

We will build any kind of Boiler you may desire. Send us your specifications and blue prints.



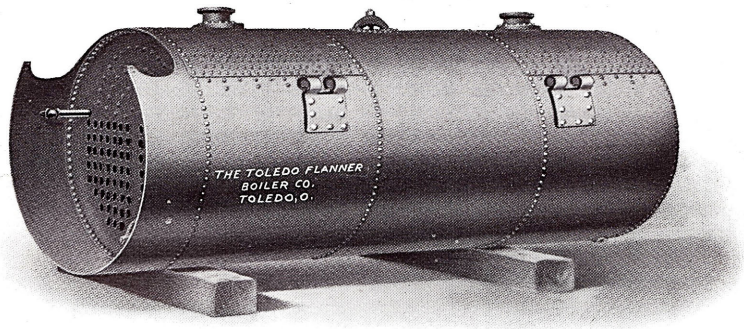
Fire Box Boiler No. 6.

Placed upon skids made portable. Write us for prices.



Return Tubular Boiler No. 3.

These boilers are built only upon special order. Our prices are reasonable and our work unexcelled. Do not fail to get our prices when you are in the market for any kind of a boiler.



Return Tubular Boiler No. 5.

These are built with lugs for suspending from steel frame. Our prices are popular and our work is most excellent.

Scotch Marine Boiler No. 1.

A Scotch Marine Boiler built by The Toledo-Flanner Boiler Company, Toledo, Ohio, U. S. A.

When in the market for self supported stacks, do not fail to write us. We can make you prices that will be of interest. All kinds of guyed stacks and breechings are also built by The Toledo-Flanner Boiler Company, Toledo, Ohio, U. S. A.

KENT'S TABLE OF SIZE OF CHIMNEYS FOR STEAM BOILERS.

Formula: H. P. $= 3.33 (A - 0.6 \sqrt{A}) \sqrt{H}$. (Assuming 1 H. P. = 5 lbs. of coal burned per hour.)

Diameter. Inches.	Area A Sq. feet.	Effective Area, $E = A - 0.6 \sqrt{A}$. Sq. feet.	HEIGHT OF CHIMNEY. COMMERCIAL HORSE POWER OF BOILER.														Equivalent Square Chimney. Side of Square, $\sqrt{E} + 4$ in.
			50 ft.	60 ft.	70 ft.	80 ft.	90 ft.	100 ft.	110 ft.	125 ft.	150 ft.	175 ft.	200 ft.	225 ft	250 ft.	300 ft.	
18	1.77	.97	23	25	27	29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
21	2.41	1.47	35	38	41	44	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19
24	3.14	2.08	49	54	58	62	66	.....	.....	.....	.....	.....	.....	.....	.....	.....	22
27	3.98	2.78	65	72	78	83	88	.....	.....	.....	.....	.....	.....	.....	.....	.....	24
30	4.91	3.58	84	92	100	107	113	119	.....	.....	.....	.....	.....	.....	.....	.....	27
33	5.94	4.48	...	115	125	133	141	149	156	.....	.....	.....	.....	.....	.....	.....	30
36	7.07	5.47	...	141	152	163	173	182	191	204	.....	.....	.....	.....	.....	.....	32
39	8.30	6.57	..	.....	183	196	208	219	229	245	.....	.....	.....	.....	.....	.....	35
42	9.62	7.76	...	.....	216	231	245	258	271	289	316	.....	.....	.....	.....	.....	38
48	12.57	10.44	.	.....	.....	311	330	348	365	389	426	.....	.....	.....	.....	.....	43
54	15.90	13.51	.....	.....	.....	.....	427	449	472	503	551	595	.....	.....	.....	.....	48
60	19.64	16.98	.....	.....	.....	.....	536	565	593	632	692	748	.....	.....	.....	.....	54
66	23.76	20.83	..	.....	.....	.....	.....	694	728	776	849	918	981	.....	.....	.....	59
72	28.27	25.08	....	.....	.....	.....	.....	835	876	934	1023	1105	1181	1253	.....	.....	64
78	33.18	29.73	.....	.....	.....	.....	.....	.....	1038	1107	1212	1310	1400	1485	1565	.....	70
84	33.48	34.76	.....	.....	.....	.....	.....	.....	1214	1294	1418	1531	1637	1736	1830	2005	75
90	44.18	40.19	.....	.....	.....	.....	.....	.....	.....	1496	1639	1770	1893	2008	2116	2318	80
96	50.27	46.01	.....	.....	.....	.....	.....	.....	.....	1712	1876	2027	2167	2298	2423	2654	86
102	56.75	52.23	.....	.....	.....	.....	.....	.....	.....	1944	2130	2300	2459	2609	2750	3012	91
108	63.62	58.83	.....	.....	.....	.....	.....	.....	.....	2090	2399	2592	2771	2939	3098	3393	96
114	70.88	65.83	....	.....	.....	.....	.....	.....	.....	.....	2685	2900	3100	3288	3466	3797	101
120	78.54	73.22	.....	.....	.....	.....	.....	.....	.....	.....	2986	3226	3448	3657	3855	4223	107
132	95.03	89.18	.....	.....	.....	.....	.....	.....	.....	.....	3637	3929	4200	4455	4696	5144	117
144	113.10	106.72	.....	.....	.....	....	.....	.....	.....	.....	4352	4701	5026	5331	5618	6155	128

For pounds of coal burned per hour for any given size of chimney, multiply the figures in the table by 5.

HEATING SURFACE OF BOILER TUBES

Diameter × 3.1416 = circumference × 12 = number of square inches in tube one foot of length ÷ 144 = number of square feet (in decimals) one foot of length.

Example· Two inch tube one foot in length resolves itself into the following.

$$\frac{2 \times 3.1416 = 6.2832 \times 12 = 75.3984}{144} = .5236$$

Diam Inches.	Multiplier	Diam. Inches.	Multiplier	Diam. Inches.	Multiplier	Diam. Inches	Multiplier	Diam. Inches.	Multiplier	Diam. Inches.	Multiplier.
1	2618	8	2.0944	18	4.7124	32	8.3776	46	12.0428	60	15.708
1¼	.3272	8¼	2.1598	18½	4.8433	32½	8.5085	46½	12.1735	60½	15.8389
1½	.3927	8½	2.2253	19	4.9742	33	8.6394	47	12.3045	61	15.9698
1¾	.4581	8¾	2.2907	19½	5.1051	33½	8.7703	47½	12.4355	61½	16.1007
2	.5236	9	2.3562	20	5.236	34	8.9012	48	12.5664	62	16.2316
2¼	.589	9¼	2.4216	20½	5.3669	34½	9.0321	48½	12.6973	62½	16.3625
2½	.6545	9½	2.4872	21	5.4978	35	9.163	49	12.8282	63	16.4934
2¾	7199	9¾	2.5525	21½	5.6287	35½	9.2939	49½	12.9591	63½	16.6243
3	7854	10	2.618	22	5.7596	36	9.4248	50	13.09	64	16.7552
3¼	8508	10¼	2.6834	22½	5.8905	36½	9.5557	50½	13.2209	64½	16.8861
3½	.9163	10½	2.7489	23	6.0214	37	9.6866	51	13.3518	65	17.017
3¾	.9817	10¾	2.8143	23½	6.1523	37½	9.8175	51½	13.4827	65½	17.1479
4	1.0472	11	2.8798	24	6.2832	38	9.9484	52	13.6136	66	17.2788
4¼	1.1126	11¼	2.9452	24½	6.4141	38½	10.0793	52½	13.7445	66½	17.4097
4½	1.1781	11½	3.0107	25	6.545	39	10.2102	53	13.8754	67	17.5406
4¾	1.2435	11¾	3.0761	25½	6.6759	39½	10.3411	53½	14.0063	67½	17.6715
5	1.309	12	3.1416	26	6.8034	40	10.472	54	14.1372	68	17.8024
5¼	1.3744	12¼	3.2725	26½	6.9377	40½	10.6029	54½	14.2681	68½	17.9333
5½	1.4399	13	3.4037	27	7.0686	41	10.7338	55	14.399	69	18.0642
5¾	1.5053	13½	3.5343	27½	7.1995	41½	10.8647	55½	14.5299	69½	18.1951
6	1.5708	14	3.6652	28	7.3384	42	10.9956	56	14.6608	70	18.326
6¼	1.6362	14½	3.7961	28½	7.4614	42½	11.1265	56½	14.7917	70½	18.4569
6½	1.7017	15	3.927	29	7.5913	43	11.2574	57	14.9226	71	18.5868
6¾	1.7671	15½	4.0579	29½	7.7231	43½	11.3883	57½	15.0536	71½	18.7187
7	1.8326	16	4.1888	30	7.8554	44	11.5192	58	15.1844	72	18.8496
7¼	1.8980	16½	4.3197	30½	7.9849	44½	11.6501	58½	15.3153	78	20.3370
7½	1.9335	17	4.4506	31	8.1158	45	11.781	59	15.4462	84	21.9912
7¾	2.0289	17½	4.5815	31½	8.2467	45½	11.9119	59½	15.5771	96	25.1328

Deduct 25% in figuring on heating surface in internal furnaces when grates are placed inside.

PROPERTIES OF SATURATED STEAM.

Ice is liquified and becomes water at 32° F. Above this point water increases in temperature up to the steaming point, nearly at the rate of 1° for each unit of heat added per pound of water. The steaming point (212° at atmospheric pressure) rises as the superimposed pressure increases, but at a decreasing ratio; as, for example, at atmospheric pressure it takes 3½° to add a pound, while at 150 pounds ½° gives the same increase of pressure.

For each unit of heat added above the steaming point, a portion of the water is converted into steam, having the same temperature and the same pressure as that at which it is evaporated. The heat so absorbed is called "Latent Heat." The amount of heat rendered latent by each pound of water in becoming steam varies at different pressures, decreasing as the pressure increases. This latent heat added to the sensible heat (or the thermometric temperature) constitutes the "Total Heat." The "total heat" being greater as the pressure increases, it will take more heat, and consequently more fuel, to make a pound of steam the higher the pressure.

Saturated steam cannot be cooled except by lowering its pressure, the abstraction of heat being compensated by the latent heat of a portion which is condensed. Neither can steam, in contact with water, be heated above the temperature normal to its pressure.

The density of saturated steam varies from ⅝ that of air of the same temperature and pressure, below that of the atmosphere, to ⅔ at 100 pounds. Its weight per cubic foot varies as the 17th root of the 16th power, and may be found by the formula: $D = .003027\,p^{.941}$, which is correct to within ½ per cent. up to 250 pounds pressure.

The following table gives the properties of steam at different pressures — from 1 lb. to 500.

TABLE OF PROPERTIES OF SATURATED STEAM, Partly from C. H. Peabody's Tables.

Pressure in pounds per square inch above vacuum.	Temperature in degrees, Fahrenheit.	Total heat in heat units from water at 32°	Heat in liquid from 32° in units.	Heat of vaporization, or latent heat in heat units.	Density or weight of cubic foot in pounds.	Volume of one pound in cubic feet.	Factor of equivalent evaporation at 212°.	Total pressure above vacuum.
1	101.99	1113.1	70.0	1043.c	0.00299	334.5	.9661	1
2	126.27	1120.5	94.4	1026.1	0.00576	173.6	.9738	2
3	141.62	1125.1	109.8	1015.3	0.00844	118.5	.9786	3
4	153.09	1128.6	121.4	1007.2	0.01107	90.33	.9822	4
5	162.34	1131.5	130.7	1000.8	0.01366	73.21	.9852	5
6	170.14	1133.8	138.6	995.2	0.01622	61.65	.9876	6
7	176.90	1135.9	145.4	990.5	0.01874	53.39	.9897	7
8	182.92	1137.7	151.5	986.2	0.02125	47.06	.9916	8
9	188.33	1139.4	156.9	982.5	0.02374	42.12	.9934	9
10	193.25	1140.9	161.9	979.0	0.02621	38.15	.9949	10
15	213.03	1146.9	181.8	965.1	0.03826	26.14	1.0003	15
20	227.95	1151.5	196.9	954.6	0.05023	19.91	1.0051	20
25	240.04	1155.1	209.1	946.0	0.06199	16.13	1.0099	25
30	250.27	1158.3	219.4	938.9	0.07360	13.59	1.0129	30
35	259.19	1161.0	228.4	932.6	0.08508	11.75	1.0157	35
40	267.13	1163.4	236.4	927.0	0.09644	10.37	1.0182	40
45	274.29	1165.6	243.6	922.0	0.1077	9.285	1.0205	45
50	280.85	1167.6	250.2	917.4	0.1188	8.418	1.0225	50
55	286.89	1169.4	256.3	913.1	0.1299	7.698	1.0245	55
60	292.51	1171.2	261.9	909.3	0.1409	7.097	1.0263	60
65	297.77	1172.7	267.2	905.5	0.1519	6.583	1.0280	65
70	302.71	1174.3	272.2	902.1	0.1628	6.143	1.0295	70
75	307.38	1175.7	276.9	898.8	0.1736	5.760	1.0309	75
80	311.80	1177.0	281.4	895.6	0.1843	5.426	1.0323	80
85	316.02	1178.3	285.8	892.5	0.1951	5.126	1.0337	85
90	320.04	1179.6	290.0	889.6	0.2058	4.859	1.0350	90
95	323.89	1180.7	294.0	886.7	0.2165	4.619	1.0362	95
100	327.58	1181.9	297.9	884.0	0.2271	4.403	1.0374	100
105	331.13	1182.9	301.6	881.3	0.2378	4.205	1.0385	105
110	334.56	1184.0	305.2	878.8	0.2484	4.026	1.0396	110
115	337.86	1185.0	308.7	876.3	0.2589	3.862	1.0406	115
120	341.05	1186.0	312.0	874.0	0.2695	3.711	1.0416	120
125	344.13	1186.9	315.2	871.7	0.2800	3.571	1.0426	125
130	347.12	1187.8	318.4	869.4	0.2904	3.444	1.0435	130
140	352.85	1189.5	324.4	865 1	0.3113	3.212	1.0453	140
150	358.26	1191.2	330.0	861.2	0.3321	3.011	1.0470	150
160	363.40	1192.8	335.4	857.4	0.3530	2.833	1.0486	160
170	368.29	1194.3	340.5	853.8	0.3737	2.676	1.0502	170
180	372.97	1195.7	345.4	850.3	0.3945	2.535	1.0517	180
190	377.44	1197.1	350.1	847.0	0.4153	2.408	1.0531	190
200	381.73	1198.4	354.6	843.8	0.4359	2.294	1.0545	200
225	391.79	1201.4	365.1	836.3	0.4876	2.051	1.0576	225
250	400.99	1204.2	374.7	829.5	0.5393	1.854	1.0605	250
275	409.50	1206.8	383.6	823.2	0.5913	1.691	1.0632	275
300	417.42	1209.3	391.9	817.4	0.644	1.553	1.0657	300
325	424.82	1211.5	399.6	811.9	0.696	1.437	1.0680	325
350	431.90	1213.7	406.9	806.8	0.748	1.337	1.0703	350
375	438.40	1215.7	414.2	801.5	0.800	1.250	1.0724	375
400	445.15	1217.7	421.4	796.3	0.853	1.172	1.0745	400
500	466.57	1224.2	444.3	779.9	1.065	.939	1.0812	500

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THE NEWELL B. NEWTON CO.
TOLEDO, OHIO